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ESDCD news

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Earth and Space Data Computing Division

Earth Sciences Directorate, Goddard Space Flight Center

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National Invasive Species Forecasting

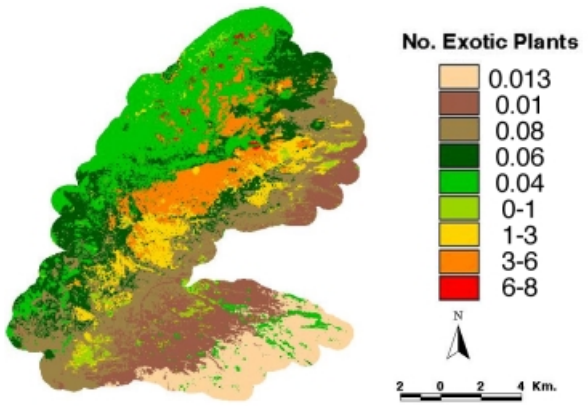
From northern snakehead fish to kudzu, non-native species have long been introduced into the U.S. either intentionally or unintentionally. If a non-native species has a harmful effect on the nearby environment, economy, or inhabitants, it is considered invasive. According to a Cornell University study, these invasive species can displace local animal and plant life, inflicting more than $138 billion in damage on the U.S. every year.

The spread of invasive species is in many ways shaped by temperature, precipitation, and other climate factors. NASA's ability to observe climate through remote sensing technologies can greatly bolster the accuracy of attempts to model invasive species movement. In return, reliable knowledge of invasive species' movement and environmental impact could be incorporated into NASA's predictive models for global carbon storage, disease outbreaks, and other research topics.

NASA's Computational Technologies (CT) Project is funding the ESDCD's work with the U.S. Geological Survey (USGS) National Institute of Invasive Species Science (NIISS). This new consortium brings together the USGS Earth Resources Observation Systems (EROS) Data Center, Colorado State University (CSU), and a wide range of federal and state agencies to develop predictive models of invasive species distributions.

ESDCD personnel are providing their expertise in parallel computing and large-scale Earth modeling to the consortium. "When we have effective models and can generate forecasts of where non-native species may move, we can set priorities for prevention and control before the species do damage," says John Schnase, an ESDCD senior scientist and principal investigator for the endeavor.

In the first stage of this partnership, James A. Smith, Curt Tilmes, Jeffrey Pedelty, and Jeffrey Morisette of GSFC's Laboratory for Terrestrial Physics worked with CSU investigators Thomas Stohlgren, Mohammad Kalkhan, and Robin Reich. Pedelty and Morisette repackaged existing modeling routines into a single processor prototype. The prototype modeling system is used to predict likely locations for invasive species manifestations based on environmental data collected in areas of prior manifestation. The prototype is designed for use in the Interactive Data Language (IDL) environment, which is software for data analysis, visualization, and application development.



The ESDCD helped increase the efficiency of a model that predicts the presence of exotic, or invasive, species in a chosen location. Image credit: M.A. Kalkhan, Natural Resource Ecology Laboratory, Colorado State University, Ft. Collins

Their work improved the code's process automation and serial-processor performance speed so dramatically that a simulation that previously required 2 weeks of computation time needed only a few hours after the redesign. One source of timesaving came from eliminating the need for manual intervention steps such as format conversions. The improvement in performance speed was noted after running the model for selected test sites, such as the Cerro Grande Wildfire Site, NM.

By reducing computation time, the NIISS can enter more environmental input to improve the resolution and detail of its invasive species predictions. Also, the model's area of coverage may be increased to cover an entire state or region of the country.

In the next phase, the ESDCD will develop a parallelized version of the model with a Web-accessible interface. The interface will open the modeling suite's predictive capabilities to end users who may not have the scientific background or the computational resources to run the suite themselves. During its development, the system will be tested using the ESDCD's computing clusters at GSFC.

When development is completed, a production system will be powered by an affordable, high-performance Beowulf computing cluster that will be installed at the USGS Fort Collins Science Center. John Dorband of the ESDCD is serving as technical advisor for the installation. This new system will place predictive capabilities in the hands of scientists at the NIISS and other government agencies.

Another important component of ESDCD support is model integration of remote measurements from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) instrument onboard the Terra satellite. MODIS records vegetation structure, landforms, and surface soil properties. With such data, scientists will be able to differentiate between local and invasive species in maps of biological resources.

More information can be found in the August 2002 Earth Observation Magazine article "The National Invasive Species Forecasting System: A Strategic NASA/USGS Partnership to Manage Biological Invasions," by Schnase, Stohlgren, and Smith.

http://ct.gsfc.nasa.gov

http://www.nrel.colostate.edu/projects/niiss/niiss.html

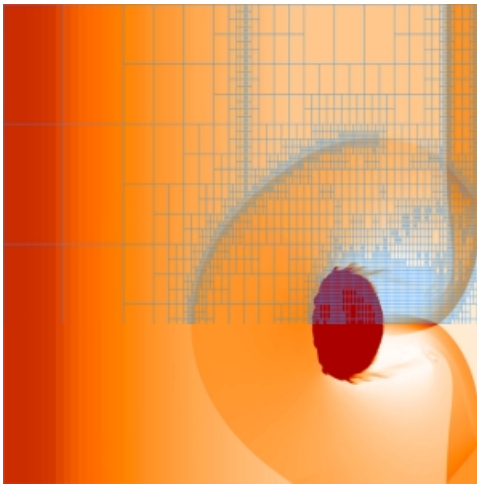
http://www.eomonline.com/Common/currentissues/Aug02/schnase.htm

Computational Technologies Project

Shining IBEAM on the Universe

An investigator team has completed the first simulation using a new astrophysical software framework being designed to ultimately model almost any phenomenon in the universe. The inaugural calculation with Interoperability Based Environment for Adaptive Meshes (IBEAM) tests the software's ability to represent gamma-ray bursts, colossal explosions that outshine one billion suns.

This CT team's simulation models a shockwave hitting and being reflected by a dense gas cloud. This interaction is a possible component of a gamma-ray burst. "If you think of it as baking a cake, it is one of the ingredients," says Alan Calder, research scientist in the Department of Astronomy and Astrophysics at the University of Chicago (UC). "This is at the level of flour."



A shockwave interacts with a dense gas cloud in the first IBEAM simulation. The ESDCD-developed PARAMESH Adaptive Mesh Refinement software package is a key component of IBEAM. Image credit: Alan Calder, University of Chicago

The ingredients in the IBEAM framework are software modules that work together, or interoperate, to solve a problem. Computer scientist Paul Saylor leads IBEAM development from the University of Illinois at Urbana-Champaign, with collaborating organizations across the U.S. and in Europe.

The base module for IBEAM is the Flash code from the Department of Energy's Accelerated Strategic Computing Initiative/Alliances Center for Astrophysical Thermonuclear Flashes at UC. The shock-gas cloud simulation draws on the first new IBEAM module, which models how gas flows at

velocities approaching the speed of light. This physical behavior is known as relativistic hydrodynamics.

IBEAM incorporates the Parallel Adaptive Mesh Refinement (PARAMESH) software, written by ESDCD scientists Peter MacNeice and Kevin Olson. This technique increases resolution only where it is needed to capture intricate details, enabling a more powerful simulation on the same size computer.

Such efficiency will be crucial when IBEAM programmers add radiation transport—describing how light moves through space and time. A single beam of light has three spatial coordinates and points at two angles. Evolving many light beams and calculating energy levels make this "a 7-dimensional problem, which will bring the biggest machines we have to their knees," Calder says. The team is planning to use the NCCS's 1,392-processor HP/Compaq AlphaServer SC45 and CT's new 536-processor Thunderhead PC cluster.

IBEAM must include radiation transport because gamma-ray bursts are essentially expanding fireballs of photons. Like the ebbs and flows of the tides, the number of photons fluctuates over time. Space-based observatories can measure these changes in the form of light curves.

The Burst And Transient Source Experiment (BATSE) onboard NASA's Compton Gamma Ray Observatory captured 2,704 gamma-ray bursts during its operational lifetime (1991–2000). After the initial burst, the fireball cools down and the energy goes to longer wavelengths such as optical or infrared, explains Chryssa Kouveliotou, senior research scientist at NASA Marshall Space Flight Center. The Hubble Space Telescope and other observatories have measured a handful of "afterglow" light curves that can be compared with their BATSE gamma-ray counterparts.

"We look at the light curves for variability, if they are random or periodic," Kouveliotou says. "Recent studies indicate that variability may be associated with burst luminosity, and we may be able to get the distance, which we don't know for many gamma-ray bursts." The average estimated distance is 6 billion light-years from Earth.

Light curve variability also may offer clues about a burst's structure. "There are two schools of thought about time variability," says Doug Swesty, research assistant professor of physics and astronomy at Stony Brook University, State University of New York. According to Swesty, one possibility is that the fireball interacts with surrounding blobs of matter, as in the first IBEAM calculation. A second option is that multiple shockwaves in the fireball interact with each other.

"IBEAM will simulate both of these scenarios to see what light curves they produce," Swesty says. "The framework is thus crucial for analyzing the observational data about gamma-ray bursts."

http://ct.gsfc.nasa.gov
http://www.ibeam.org

NASA at SC2002

ESDCD Supports NASA, Defense Booths and Keynote Session

NASA's SC2002 research exhibit featured videos and posters from five NASA centers. Image credit: Lara Clemence, GST

SC2002 drew the largest crowds in the 15-year history of the conference, with 7,200 people converging into the Baltimore Convention Center November 16–22, 2002. Many attendees visited NASA's research exhibit, one of a record 223 exhibits covering nearly 2 acres. Ames Research Center (ARC), Glenn Research Center, GSFC, Jet Propulsion Laboratory, and Langley Research Center collaborated on the exhibit. The following six demonstration groups featured ESDCD scientists, supercomputer users, and collaborators:

- Ultra-High Resolution Astronomy: Phasing of Arrays of Formation Flying Spacecraft—ESDCD scientist Richard Lyon showed animations of future space telescopes that will resolve the stellar disks of nearby stars and planets.

- Modeling the Earth's Atmosphere—Bill Putman, Will Sawyer, and Bowen Shen of GSFC's Data Assimilation Office (DAO) demonstrated the DAO's next-generation finite volume General Circulation Model, which has been running on the

ESDCD's HP/Compaq AlphaServer SC45 and 512-processor SGI Origin 3800.

- IBEAM—CT Project investigators Swesty and Calder showed simulations of a possible gamma-ray burst component (see "Shining IBEAM on the Universe," page 2).

- Chombo Framework for Block-Structured Adaptive Mesh Refinement Applications—Visualizations by CT investigator Dan Martin of Lawrence Berkeley National Laboratory depicted co-rotating vortex rings that mix fluids in micro-gravity environments.

- Sci-Interactives: Science Outreach from Truth-N-Beauty Software and CT—Ted Pawlicki of Truth-N-Beauty Software demonstrated interactive science games exploring the collapse of interstellar clouds and the creation of aurora in Earth's magnetosphere.

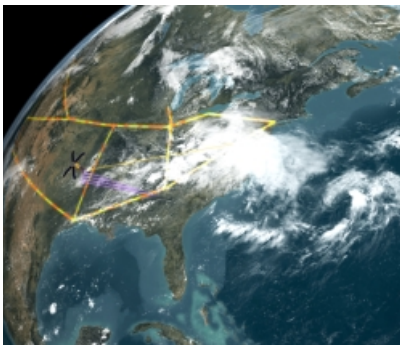
- Cost-Effective Advanced Computing Technologies—Long-term ESDCD collaborators led by Walt Ligon of Clemson University showed their latest Beowulf/Linux cluster developments, including a portable, see-through cluster named Aetherwulf and the Coven framework for collaborative software development.

Richard Lyon (center right) of the ESDCD explains future space telescope optics, while Dan Martin (center left) of Lawrence Berkeley National Laboratory describes CT Project-funded simulations of microgravity fluid flows. Image credit: Jarrett Cohen, GST

In addition to the demonstrations, three ESDCD posters appeared on the exhibit's "wall of fame." Two NASA Center for Computational Sciences (NCCS) posters highlighted its supercomputers and major computational science users. A Minority University Space Interdisciplinary Network (MU-SPIN) program poster described its outreach programs for minority institutions.

Jarrett Cohen of GST served as GSFC's SC2002 coordinator. This activity centered on recruiting high-impact demonstrations and supporting their computing and networking needs for the conference. The latter included securing free loans of workstations from Apple Computer and Hewlett-Packard. Cohen also participated in decisions about the booth design and assisted in the production of media materials and posters.

At the Department of Defense (DOD) booth, a real-time High Definition Television (HDTV) data-streaming demonstration by the University of Southern California's Information Sciences Institute benefited from the ESDCD High End Computer Network (HECN) team's network expertise. William Fink worked with Paul Lang of ADNET to bring 9,000-byte Ethernet jumbo-frame technology to SC2002's network through a HECN Gigabit Ethernet (GE) switch. This resulted in performance improvements of 6 times more than that achievable with standard 1,500-byte Ethernet frames. Because the jumbo frames are ideal for large transmissions, the demo provided an excellent broadcast with a sustained 850 Mbps video-over-Internet protocol stream across a metropolitan area using standard fiber optic networks.
http://www.east.isi.edu/projects/NMAA/hdtv/index.html



A frame from the SC2002 opening video showing the SeaStar satellite collecting data from the southern U.S. Yellow lines indicate the Abilene network backbone. Image credit: SVS

Finally, SC2002's keynote address session featured the Scientific Visualization Studio's (SVS) "SC2002 Conference Opening Video," produced by Jarrett Cohen and Stuart Snodgrass of GST. The video creatively combined Baltimore scenes with visualizations and computing equipment footage from GSFC and nearly 20 other supercomputer sites, including an SVS-produced zoom to the convention site.
http://svs.gsfc.nasa.gov/vis/a000000/a002600/a002641/index.html
http://www.nas.nasa.gov/SC2002/

NCCS Highlights

NCCS Retires Two Cray Systems

At the end of December 2002, the NCCS discontinued production use on two of its computers: a Cray T3E and a Cray SV1. The users of these two systems have moved their workloads to the NCCS HP/Compaq AlphaServer SC45. The peak system performance of the SC45 is nearly 4 times that of the discontinued Cray computers.

The decommissioning of the Cray T3E marks an end to a machine that once ranked fifth in the world and marked the NCCS's shift from vector to large-scale parallel production supercomputing. It also marks the first time in 13 years that the NCCS has not had Cray computer equipment in production.

DAO Code Optimization

A tuning of an ozone analysis code used by Ivanka Stajner of GSFC's DAO resulted in a net improvement of a 12-times reduction in wall-clock time for the group. Gerhard Theurich, of the NCCS applications team and SGI, ran serial optimizations that yielded a 1.5-times performance increase, while the introduction of parallel capabilities yielded an additional factor of 8 times using 16 processors on an SGI Origin 3800.

Workshops

The NCCS Advanced Software Technology Group held four "getting started" workshops for users moving to the NCCS's new massively parallel SC45 supercomputers. The workshops covered the basics of parallel computing using the OpenMP (shared memory) and MPI (distributed memory) programming models. The 16 attendees were from the DAO, the Laboratory for Terrestrial Physics, and the Mesoscale Atmospheric Processes Branch.

A team from the University of Greenwich, U.K., and NASA ARC presented a hands-on tutorial on Parawise/CAPO. This software, which is available at the NCCS, can semi-automatically parallelize scientific applications. By significantly reducing parallel processing time, this suite of tools may have immense value as the NCCS continues to deliver parallel resources to a growing segment of its scientific community.
http://esdcd.gsfc.nasa.gov/SCB

Outreach

MU-SPIN Initiatives

MU-SPIN, with Bowie State University and the NASA Student Involvement Program (NSIP), has partnered with Communities In Schools (CIS) of Prince George's (PG) County to provide network infrastructure, connectivity, computers, educational resources, and teacher training at seven PG County elementary schools. CIS, a national program with nearly 200 independently incorporated local and state CIS chapters, champions the connection of needed community resources with schools to help young people successfully learn, stay in school, and prepare for life.

The MU-SPIN coordination office is lending its support to two NASA initiatives, the NASA Astrobiology Institute (NAI) and the Educator Astronaut program. MU-SPIN hosted the Minority Institute Astrobiology Collaborative (MIAC) introductory workshop at GSFC September 18–20, 2002. The ideas and enthusiasm from that initial workshop were captured on video and CD-ROM by the MU-SPIN staff and were presented at the 2003 General Meeting of the NAI at Arizona State University on February 10–12, 2003. MU-SPIN staff also supported visits by NASA Headquarters managers to two District of Columbia elementary schools to do usability testing for the new Educator Astronaut Web site. NASA Administrator O'Keefe announced the Educator Astronaut program on January 21, 2003.
http://www.edspace.nasa.gov
http://mu-spin.gsfc.nasa.gov

Student Programs Bring New Talent

The Visiting Student Enrichment Program (VSEP) is looking for GSFC sponsors and/or mentors for the 2003 Summer program. Goddard projects directly benefit from the work performed by the students and NASA benefits through the encouragement of students in pursuit of NASA-related careers. Although there is no promise of future employment, the ESDCD and other areas of NASA currently have several employees who were students in either the VSEP program or similar NASA educational programs. If you would like more information about VSEP or are interested in sponsoring or mentoring a student, please contact Marilyn Mack of the ESDCD at 301-286-4638 or Marilyn.J.Mack@nasa.gov.
http://esdcd.gsfc.nasa.gov/VSEP/

The Science of Star Trek

In addition to managing the Global Observations to Benefit the Environment (GLOBE) program's scientific visualization staff, David Batchelor is a published author in quantum theory physics and a recognized expert on the feasibility of the science and technology used in Star Trek. He was most recently quoted in the December 13, 2002, nationalgeographic.com news article, "The Science of Star Trek." Batchelor helped to separate science fact from science fiction in the article, which marked the opening of the movie, "Star Trek Nemesis." Batchelor has been quoted on this topic in the books, "Future Perfect: How Star Trek Conquered Planet Earth," by Jeff Greenwald, Viking Penguin, 1998; and "Advanced English Course," by Marina Engelking and Gloria MacPherson, Oxford University Press Canada, 1997. He has been quoted in several publications over the past decade, including Florida Today and the San Francisco Chronicle. His expertise has also been sought by national news shows and NASA programs.
http://news.nationalgeographic.com/news/2002/12/1213_021213_tvstartrek.html
http://ssdoo.gsfc.nasa.gov/education/just_for_fun/startrek.html

ESDCD Updates

Earth Alert System (EAS) Supports Inauguration

Maryland Emergency Management Administration (MEMA) requested that the EAS project provide communications for the 2003 Maryland Gubernatorial Inauguration events. EAS set up a field emergency operations center and provided field communications for MEMA personnel. EAS provided geographic information systems (GIS) maps of Annapolis with Global Positioning System (GPS) locations for personnel and vehicles. The maps were displayed in Camp Fretterd in Reisterstown, in a mobile center in Annapolis, and on closed circuit television in the Maryland State House. MEMA reported that the equipment greatly improved its operations. EAS is planning to develop a memorandum with MEMA to extend the use of the equipment for 1 year. During that time, GSFC remote sensing technologies and information dissemination technologies will be introduced to MEMA partner organizations such as the Maryland National Guard and local emergency management organizations.

Open Group Award

The Goddard Scientific and Engineer Workstation Procurement (SEWP) team was a recipient of a group award from The Open Group in 2002. The Open Group, based in the U.K., recognized SEWP's adherence to key industry IT standards, including UNIX certification and Linux, in its procurement process. ESDCD personnel supporting this effort include George Rumney, Co-Technical Lead for Procurement, and Tom Schardt, Compute Server Technical Advisory Committee Chair. Working with GSFC's Information Services and Advanced Technology Division, the Science Computing Branch has been committed to the development of SEWP as an integral part of NASA's procurement process.

http://www.gsfc.nasa.gov/goddardnews/20021025/sewp.html
http://www.sewp.nasa.gov/

Geospatial One-Stop

Jeff de La Beaujardiere has assumed the role of Portal Manager for the Geospatial One-Stop (GOS) project, an interagency effort that is 1 of 24 U.S. Office of Management and Budget E-Government initiatives. The project will implement an online portal providing access to reliable "Framework Data" (commonly needed types of geospatial data) and other related information about the Earth. De La Beaujardiere led a team to define the technical requirements and architecture of the portal, and manages an Open GIS Consortium Interoperability Initiative to develop a portal by June 2003. NASA, as represented by its Geospatial Interoperability Office, is a significant participant in GOS. The initiative will benefit NASA's Earth Science Enterprise as well as other areas of broad national interest including homeland security.

For information or questions contact:
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